IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of

BOURRET, et al. — Atty. Ref.: RYM-36-1949

Serial No. 10/560,448 — TC/A.U.: 2422

Filed: December 13, 2005 — Examiner: Trang U. Tran

For: METHOD AND SYSTEM FOR VIDEO QUALITY ASSESSMENT

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April 12, 2011

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

Sir:

Appellant hereby **appeals** to the Board of Patent Appeals and Interferences from the last decision of the Examiner.

TABLE OF CONTENTS

(I) REAL PARTY IN INTEREST

The real party in interest is British Telecommunications public limited company, a corporation of the country of England.

(II) RELATED APPEALS AND INTERFERENCES

The appellant, the undersigned, and the assignee are not aware of any related appeals, interferences, or judicial proceedings (past or present), which will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

(III) <u>STATUS OF CLAIMS</u>

Claims 1-17 and 20-53 are pending. Claims 1-17 and 20-53 have been rejected. The rejections of claims 1-17 and 20-53 are being appealed

Claims 18-19 have been canceled. Claims 18-19 thus do not form a part of this appeal.

(IV) STATUS OF AMENDMENTS

A Response was filed on December 15, 2010 (i.e., filed after the date of the Final Rejection). However, that Response did not include any amendments to the claims or specification.

Accordingly, the claims presented in this Appeal Brief stand as presented in the Amendment/Response filed August 9, 2010.

(V) SUMMARY OF CLAIMED SUBJECT MATTER

A listing of each independent claim, each dependent claim argued separately is provided below including exemplary reference(s) to page and line number(s) of the specification.

1. A video quality assessment method [Figs. 3-5; pg. 2, ll. 33-34] comprising:

matching, by execution of a computer system, sub-field/frame elements of a test video field/frame [6] with corresponding sub-field/frame elements of at least one reference video field/frame [8], and thereby generating for the test video field/frame [6] a matched reference field/frame [34] comprising the sub-field/frame elements of the at least one reference video field/frame [8] which match to the sub-field/frame elements of the test video field/frame [6]; [Figs. 2 and 4-5; pg. 3, ll. 1-5; pg. 8, ll. 7-20; pg. 12, l. 21 – pg. 19, l. 18; pg. 33, l. 31 – pg. 34, l. 3]

positioning, by execution of the computer system, in the matched reference video fields/frame [34] at least one of the matching sub-field/frame elements to compensate for misalignment between at least one of the sub-field/frame elements of the test video field/frame [6] and the at least one matching sub-field/frame elements; and [pg. 8, ll. 7-20; pg. 13, l. 30 – pg. 15, l. 7]

generating, by execution of the computer system, a video quality value [10] in dependence on the matched sub-field/frame elements of the test [6] and matched [34] video fields/frames so as to reduce the adverse effects of sub-field/frame misalignments between the reference [8] and test field/frames [6]. [Figs. 1 and 13; pg. 7, ll. 26 – 27; pg. 9, ll. 3-7; pg. 29, l. 20 – pg. 32, l. 31; pg. 35, ll. 1-10]

7. A method according to claim 1, wherein the matching further comprises calculating one or more matching statistic values and/or matching vectors [pg. 4, ll. 3-4;]; and wherein the generating generates the video quality parameter in further dependence on the calculated matching statistic values and/or matching vectors. [pg. 4, ll. 5-10; pg. 18, ll. 16-22]

17. A non-transitory computer readable storage medium [Fig. 14; pg. 5, l. 33 – pg. 6, l. 2; pg. 32, l. 32 – pg. 33, l. 11] storing at least one computer program which upon execution by a computer system performs a video quality assessment method [Figs. 3-5; pg. 2, ll. 33-34], the method comprising:

matching sub-field/frame elements of a test video field/frame [6] with corresponding sub-field/frame elements of at least one reference video field/frame [8], and thereby generating for the test video field/frame [6] a matched reference field/frame [34] comprising the sub-field/frame elements of the at least one reference video field/frame [8] which match to the sub-field/frame elements of the test video field/frame [6]; [Figs. 2 and 4-5; pg. 3, ll. 1-5; pg. 8, ll. 7-20; pg. 12, l. 21 – pg. 19, l. 18; pg. 33, l. 31 – pg. 34, l. 3]

shifting, by execution of the computer system, relative to the matched reference field/frame [34] at least one of the matching sub-field/frame elements to compensate for misalignment between at least one of the sub-field/frame elements of the test video field/frame [6] and the at least one matching sub-field/frame elements; and [pg. 8, ll. 7-20; pg. 13, l. 30 – pg. 15, l. 7]

generating a video quality value [10] in dependence on the matched sub-field/frame elements of the test [6] and matched reference video fields/frames [34] so as to reduce the adverse effects of sub-field/frame misalignments between the reference [8] and test field/frames [6]. [Figs. 1 and 13; pg. 7, ll. 26 – 27; pg. 9, ll. 3-7; pg. 29, l. 20 – pg. 32, l. 31; pg. 35, ll. 1-10]

20. A system [Figs. 3-6 and 14] for video quality assessment [pg. 2, ll. 33-34] comprising:

matching means [30] for matching sub-field/frame elements of a test video field/frame [6] with corresponding sub-field/frame elements of at least one reference video field/frame [8], and thereby generating for the test video field/frame [6] a matched reference field/frame [34] comprising the sub- field/frame elements of the at least one reference video field/frame [8] which match to the sub- field/frame elements of the test video field/frame [6]; [Figs. 2 and 4-5; pg. 3, ll. 1-5; pg. 8, ll. 7-20; pg. 12, l. 21 – pg. 19, l. 18; pg. 33, l. 31 – pg. 34, l. 3]

shifting means for shifting relative to the matched reference field/frame [34] at least one of the matching sub-field/frame elements to compensate for misalignment between at least one of the sub-field/frame elements of the test video field/frame [6] and the at least one matching sub-field/frame elements of the at least one reference video field/frame [8]; and [pg. 8, ll. 7-20; pg. 13, l. 30 – pg. 15, l. 7]

video processing means arranged in use to generate a video quality value [10] in dependence on the matched sub-field/frame elements of the test [6] and matched reference video fields/frames [34] so as to reduce the adverse effects of sub-field/frame misalignments between the reference [8] and test field/frames [6]. [Figs. 1 and 13; pg. 7, ll. 26 – 27; pg. 9, ll. 3-7; pg. 29, l. 20 – pg. 32, l. 31; pg. 35, ll. 1-10]

26. A system according to claim 20, wherein the matching means further comprises calculating means arranged in use to calculate one or more matching statistic values and/or matching vectors [pg. 4, ll. 3-4]; and wherein the video processing means is further arranged in

use to generate the video quality parameter in further dependence on the calculated matching statistic values and/or matching vectors. [pg. 4, ll. 5-10; pg. 18, ll. 16-22]

41. A non-transitory computer readable storage medium according to claim 17, wherein the matching further comprises calculating one or more matching statistic values and/or matching vectors [pg. 4, ll. 3-4]; and wherein the generating generates the video quality parameter in further dependence on the calculated matching statistic values and/or matching vectors. [pg. 4, ll. 5-10; pg. 18, ll. 16-22]

51. A method according to claim 1, wherein said positioning includes positioning a plurality of the matching sub-field/frame elements to compensate for misalignments between a plurality of the sub-field/frame elements of the test video field/frame [6] and the plurality of the matching sub-field/frame elements. [pg. 8, ll. 7-20; pg. 13, l. 30 – pg. 15, l. 7]

52. A non-transitory computer readable storage medium according to claim 17, wherein said positioning includes positioning a plurality of the matching sub-field/frame elements to compensate for misalignments between a plurality of the sub-field/frame elements of the test video field/frame [6] and the plurality of the matching sub-field/frame elements. [pg. 8, ll. 7-20; pg. 13, l. 30 – pg. 15, l. 7]

53. A system according to claim 20, wherein the shifting means shifts, relative to the matched reference field/frame [34], a plurality of the matching sub-field/frame elements to compensate for misalignments between a plurality of the sub-field/frame elements of the test

video field/frame [6] and the plurality of matching sub-field/frame elements of the at least one reference video field/frame. [pg. 8, ll. 7-20; pg. 13, l. 30 – pg. 15, l. 7]

(VI) <u>GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL</u>

Whether claims 1-6, 17, 20-25, 36-40 and 51-53 are anticipated under 35 U.S.C. §102(e) by Hu (U.S. Patent No. 6,483,538).

Whether claims 7-10, 26-29 and 41-44 are obvious under 35 U.S.C. §103(a) over Hu in view of Wolf et al. (U.S. Patent No. 5,446,492, hereinafter "Wolf").

Whether claims 11-16, 30-35 and 45-50 are obvious under 35 U.S.C. §103(a) over Hu in view of Wolf, and further in view of Kuhn (U.S. Patent No. 6,295,083).

(VII) ARGUMENT

Claims 1-6, 17, 20-25, 36-40 and 51-53 are not anticipated under 35 U.S.C. §102 by Hu.

Anticipation under Section 102 of the Patent Act requires that a prior art reference disclose every claim element of the claimed invention. See, e.g., *Orthokinetics, Inc. v. Safety Travel Chairs, Inc.,* 806 F.2d 1565, 1574 (Fed. Cir. 1986). Hu fails to disclose every claim element of the claimed invention. For example, Hu fails to disclose "matching, by execution of a computer system, sub-field/frame elements of a test video field/frame with corresponding sub-field/frame elements of at least one reference video field/frame, and thereby generating for the test video field/frame a matched reference field/frame comprising the sub-field/frame elements of the at least one reference video field/frame which match to the sub-field/frame elements of the test video field/frame; [and] positioning, by execution of the computer system, in the matched reference video fields/frame at least one of the matching sub-field/frame elements to compensate for misalignment between at least one of the sub-field/frame elements of the test video field/frame and the at least one matching sub-field/frame elements," as required by independent claims 1 and its dependents. Hu also fails to disclose "matching sub-field/frame elements of a test video field/frame with corresponding sub-field/frame elements of at least one reference video field/frame, and thereby generating for the test video field/frame a matched reference field/frame comprising the sub-field/frame elements of the at least one reference video field/frame which match to the sub-field/frame elements of the test video field/frame; [and] shifting, by execution of the computer system, relative to the matched reference field/frame at least one of the matching sub-field/frame elements to compensate for misalignment between at least one of the sub-field/frame elements of the test video field/frame and the at least one matching sub-field/frame elements," as required by independent claim 17 and similarly required by independent claim 20, as well as their respective dependents.

Page 4 of the Final Rejection alleges the following:

> It is noted the claimed "affecting a sub-field/frame element" can be interpreted as "affecting a sub-field **or frame element** (emphasis original)." It is noted that claims are not limited to only sub-field element but include frame element. Thus, Hu anticipates the claims because they include frame element."

The above allegations of the Final Rejection are erroneous. As described in more detail below, the Final Rejection's allegation that "affecting a sub-field/frame element" can be interpreted as "affecting a sub-field **or frame element**" is erroneous -- as this interpretation would be (A) completely inconsistent with the other explicit words of the claims and context thereof, and (B) completely inconsistent with the explicit teachings of the specification. With respect to (A), claim 1 requires, for example, "sub-field/*frame elements* of a test video field/*frame*" (emphasis added; note that "frame elements" is plural and note the other claim language "of a test video field/*frame*") and thus requires, a plurality of a sub-field elements of a test video field and/or a *plurality of sub-frame elements of a test video frame*. With respect to (B), MPEP 2111 states "During patent examination, the pending claims must be 'given their broadest reasonable interpretation *consistent with the specification* (emphasis added)'", and in the present case, the specification repeatedly and unambiguously describes a plurality of sub-frame elements as constituent parts of a test video frame. The allegation that "affecting a sub-field/frame element" can be interpreted as "affecting a sub-field **or frame element**" is thus erroneous. Instead (and as discussed in more detail below), the proper interpretation of "sub-field/frame elements" can only be interpreted as sub-field elements and/or a sub-frame elements.

(A) *The Final Rejection's alleged interpretation regarding frame element is completely inconsistent with the other explicit words of the claims and context thereof.*

Claim 1 requires: "sub-field/frame elements of a test video field/frame." In view of a proper interpretation, this claim language could be re-written as follows: "sub-field elements and/or sub-frame elements of a test video field/frame." Hence, claim requires sub-field

elements of a test video field and/or sub-frame elements of a test video frame or, more simply, sub-elements of a test video field and/or of a test video frame.

The Final Rejection's erroneous interpretation would have the following result: "sub-field elements and/or frame elements of a test video field/frame", which could be re-written as follows: "sub-field elements of a test video field and/or *frame elements of a test video frame*". The meaning of "sub-field elements of a test video field" is clear *prima facie*: the sub-field elements are constituent parts of the test video field. They are not the size of the field but will be smaller – this must be the case as a plurality of the sub-field elements belong to a single test video field.

Regarding the latter alleged interpretation of the Final Rejection, the question then arises: what meaning should be attached to the phrase "frame elements of a test video frame"? No answer would appear to be available, unless we follow the logic used above to interpret "sub-field elements", i.e. to conclude that the frame elements are constituent parts of the test video frame. This result is mandated and supported by the other claim wording. Both the sub-field elements and the frame elements are said to be "of a test field/frame." If "of a" is interpreted to mean "constituent parts of" when referring to the sub-field elements, then normal rules of interpretation require the same phrase to be interpreted in exactly the same way when applied to the frame elements.

As with the sub-field elements, this interpretation of "of a" requires that the frame elements are not the size of the frame but are smaller – as a plurality of the frame elements belong to a single test video frame. Following this line of reasoning, no significant difference can be ascertained between sub-field elements and the sub-frame elements (i.e. whether the "sub" is suppressed or not).

Moreover, claim 1 also requires:

> "positioning, by execution of the computer system, in the matched reference video fields/frame at least one of the matching sub-field/frame elements to compensate for misalignment between at least one of the sub-field/frame elements of the test video field/frame and the at least one matching sub-field/frame elements."

Hence, claim 1 includes the requirement that the sub-field/frame element be positioned in the matched reference field/frame to compensate for misalignment. The misalignment lies between sub-field/frame elements. This requirement of claim 1 is incompatible with interpreting "sub-field/frame element" to include an entire frame. How can a frame be positioned in a frame to compensate for misalignment?

Based of the explicit wording of the other claim language as well as the context provided by the other claim language, the proper interpretation of "sub-field/frame elements" as claimed is sub-field elements and/or sub-frame elements. The Final Rejection's alleged interpretation regarding a frame element (note: singular) is therefore incorrect.

(B) ***The Final Rejection's alleged interpretation regarding frame element is completely inconsistent with the specification.***

As noted above, "[d]uring patent examination, the pending claims must be 'given their broadest reasonable interpretation *consistent with the specification* (emphasis added)'" *Phillips v. AWH Corp.*, 415 F.3d 1303, 1316, 75 USPQ2d 1321, 1329 (Fed. Cir. 2005). Page 3, lines 1-5 (reproduced below with emphasis added) of the original specification reveals that the sub-field/frame elements are smaller than the corresponding field/frames:

> "the invention provides for misalignments down to a sub-field/frame level to be handled by individually matching sub-field/frame elements of a test video field/frame with sub-field/frame elements from a reference video field/frame. The use of a matching element size that is significantly smaller than the video field/frame size enables transient sub-field/frame misalignments to be effectively tracked."

Figure 4 (reproduced below) is a diagram illustrating the matching of sub-elements in an embodiment of the present invention (page 6, lines 14-15). Figure 5 (reproduced below) of

the present application is a flow diagram illustrating the steps performed in order to match the sub-field/frame elements in the embodiment of the present invention (page 6, lines 16-17). As illustrated in Figure 4, the sub-field/frame elements correspond to pixel block B – i.e. a sub-element of the field/frame which is smaller than the frame. This is described at page 13, lines 8-9 of the original specification as "wherein the present field/frame is split into *bx* by *by* pixel blocks (emphasis added)." That is, pixel block B is smaller than the field/frame to which it belongs. See also, for example, step S. 5.6 of Fig. 5 labeled "SPLIT FIELD/FRAME INTO x BY y PIXEL BLOCKS."

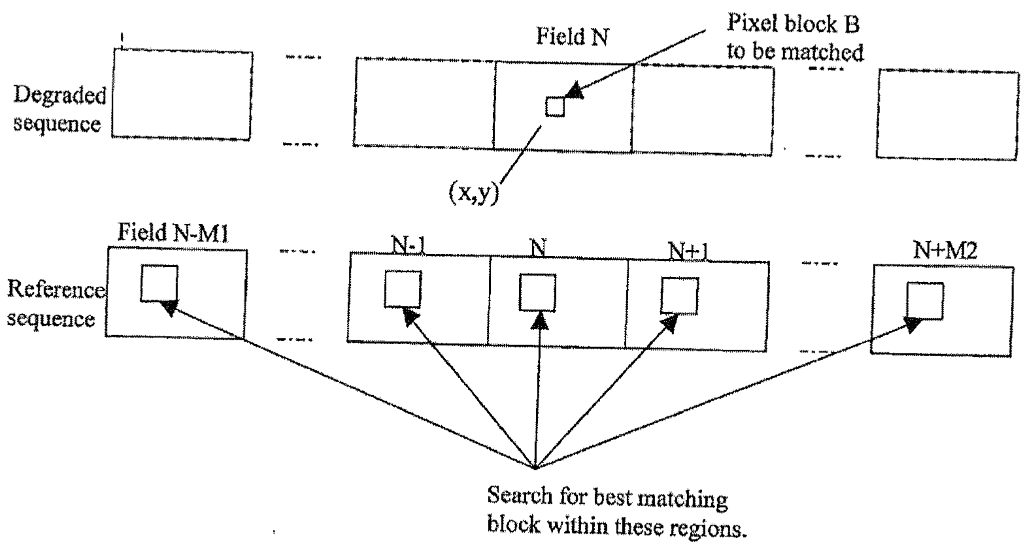

Figure 4

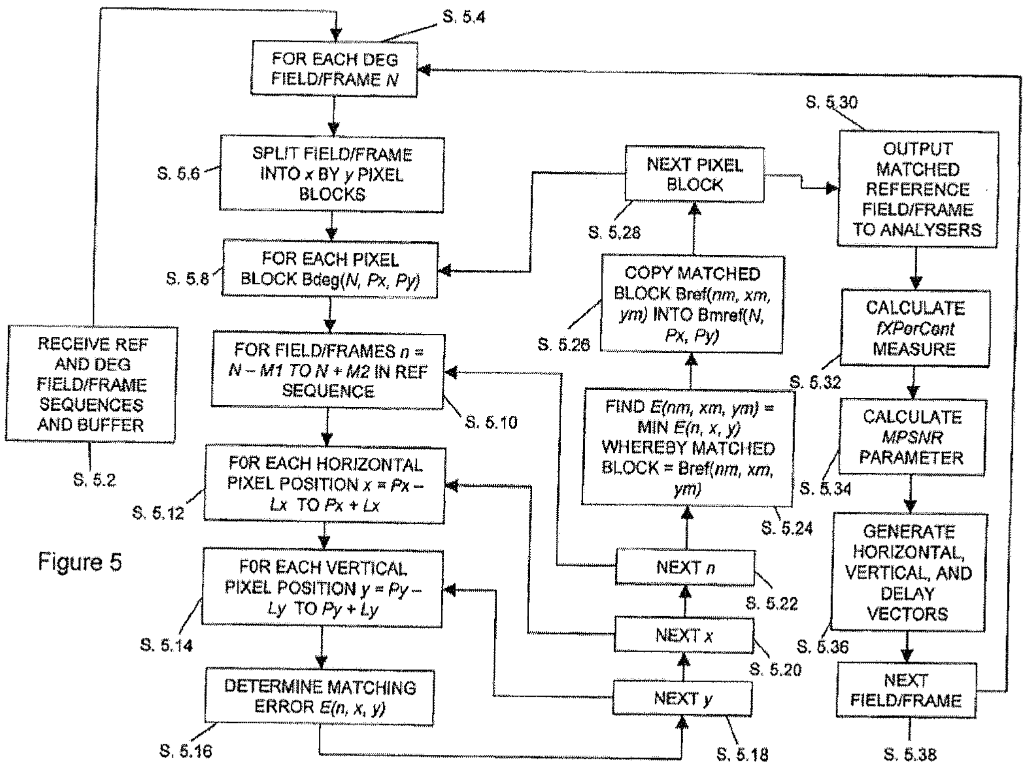

Figure 5

The interpretation of "sub-field/frame elements of a test video field/frame" as equating to: "sub-field elements and/or sub-frame elements of a test video field/frame" is also necessary in order to align the claims with the purpose and remit of the example embodiments of the invention, as set out in the original specification. For example, page 2, lines 25-27 of the original specification identifies the following problem:

> "more complex, but equally imperceptible, misalignments may also occur within a field or frame, where different <u>regions of a video field or frame</u> might be subject to different shifts, scaling, or delay."

Hence the problem addressed by the example embodiments of the present invention is concerned with sub-elements of a field or frame which are smaller than the field of frame.

At page 2, line 33 to page 3, line 5 of the original specification, the above problem set out at page 2, lines 25-27 is addressed, as follows:

> "[t]he present invention addresses the above identified problem by providing a method and system for automated video quality assessment which reduces the adverse effects of sub-field/frame misalignments between the reference and test sequences. More particularly, the invention provides for misalignments

> down to a sub-field/frame level to be handled by individually matching sub-field/frame elements of a test video field/frame with sub-field/frame elements from a reference video field/frame. The use of *a matching element size that is significantly smaller than the video field/frame size* enables transient sub-field/frame misalignments to be effectively tracked (emphasis added)."

Accordingly, the only interpretation of the claim element "sub-field/frame elements of a test video field/frame" which is supported by and consistent with the specification, which is consistent with the other claim language and makes sense in the context of the other claim language; and which addresses the identified problem, as set out in the above statement regarding the present invention, is the interpretation used consistently by the Appellant throughout the prosecution: "sub-field elements and/*or sub-frame elements*" of a test video field/frame. The Final Rejection's alleged interpretation regarding a singular frame element is therefore erroneous.

Under the above-described proper interpretation of "sub-field/frame elements of a test video field/frame" as claimed, Appellant submits that Hu fails to disclose all of the claim limitations.

Before addressing how Hu fails to disclose positioning a part of an image (e.g., how Hu fails to disclose "positioning, … at least one of the matching sub-field/frame elements" as claimed -- positioning a part of an image rather than the whole image), Appellant makes note of another deficiency of Hu with respect to independent claims 1, 17 and 20. Namely, each of the independent claims requires three video field/frames. Each of the independent claims requires: (i) a test video field/frame, (ii) a reference video field/frame, and (iii) a matched reference video field/frame, wherein matching is carried out between sub-field/frame elements of a test video field frame and a reference video field frame and positioning of sub-field/frame elements to compensate for misalignment between sub-field/frame elements is effected in the matched video field frame.

In contrast, Hu describes only test and reference frames (see, e.g., Fig. 1 of Hu). Hu fails to disclose the matched reference video field frame. This difference arises from the fact that Hu does not teach the claimed matching operation. For at least this reason alone, Hu fails to anticipate independent claims 1, 17 and 20.

Hu fails to teach the sub-field/frame alignment of the invention of the independent claims -- under the above-described proper interpretation of the claimed "sub-field/frame elements of a test video field/frame." Instead, Hu merely discloses alignment of an entire image, rather than a part. This is summarized in the last five lines of Hu's Abstract as follows (emphasis added):

> *"The steps are repeated until an end condition is achieved, at which point the value of the pixel shift position for the test block in the test image relative to the reference image is used to align the two images with high precision sub-pixel accuracy."*

In this respect, Hu is very similar to Kuhn (U.S. Patent No. 6,295,083 – cited in a rejection under 35 U.S.C. 103 and identified in the Background [page 2, line, 22 of the original specification]). The description of Hu similarly emphasizes applying a shift to the *entire* image. Alignment between reference and test images is checked using a test block (column 1, line 65 – column 2, line 3 of Hu). Although not identified in Hu, the use of a test block would seem to be for the obvious reason that it allows reliable results to be obtained from the cross-correlation calculations (see column 2, line 60 to column 3, line 20).

However, at no point does Hu describe dividing a reference image into parts and positioning or applying a pixel shift to the part(s) independent of the image as a whole.

This difference between Hu's image alignment detection and invention of the independent claims is that Hu is addressing determination of the displacement of a whole, entire image, not the matching of a plurality of subfield/frames of an image – as presently claimed (see reference to "sub-field/frame elements" in the claims – i.e. clearly requiring more than one). Admittedly, Hu is using only part of a test image and part of a reference

image, but these image parts are employed to determine the offset for the entire image and do not reduce adverse effects of sub-field/frame misalignments between the reference and test sequences.

As declared in the introduction to the description on page 2, the inventors were aware of the limitations of the method of Kuhn (U.S. Patent No. 6,295,083; cited in a rejection under 35 U.S.C. 103 and identified in the Background of the present application) which are very similar to those described in Hu. The invention of the independent claims improves upon these known methods. At page 2, lines 18-23 of the original application, Kuhn and other publications were discussed, as follows (emphasis added):

> *Problems can arise, however, with straightforward comparisons of test and reference sequences to generate the quality metrics mentioned above. For example, spatial or temporal misalignment between the* ***whole*** *or parts of the reference and the test sequence can greatly affect such measurements, but may be perceptually insignificant to a human viewer. Such misalignments must be handled if difference measures are to contribute to reliable and practical full reference assessments.*
>
> *Constant spatial and temporal misalignments are commonly encountered in full reference test situations, and can be countered by "one off" alignment applied to the* ***whole*** *reference or degraded sequence. Examples of prior art documents which deal with such one off alignments are U.S. Pat. No. 6,483,538, U.S. Pat. No. 6,259,477, U.S. Pat. No. 5,894,324,* ***U.S. Pat. No. 6,295,083****, and U.S. Pat. No. 6,271,879. Additionally, field-based spatial or temporal jitter, where misalignments might vary between fields, can be handled by similar techniques applied on a field by field basis. However, more complex, but equally imperceptible, misalignments may also occur* ***within a field or frame, where different regions of a video field or frame might be subject to different shifts, scaling, or delay****. For example, spatial warping, missing lines, or frozen blocks can occur through video processing and need to be taken into account of if a picture quality assessment metric is to be produced automatically which can be used in place of human subjective testing results.*

These misalignments within a field or frame are simply not dealt with by the teachings of Hu. In more detail, the Advisory Action fails to take note of this limitation in the independent claims, which require the shifting of a part of an image in response to the

detection of the offset of a part of an image relative to a corresponding part of another image. For example, the Advisory Action only addresses the detection of shifts, not their correction.

Any allegation that Hu describes detecting a shift between parts of two images is erroneous. What Hu is actually detecting is a shift between two entire, whole images by taking measurements in a part of each image. In more detail, the Examiner quotes Hu at column 3, lines 11-14, as follows: *"[t]he position of a peak in the surface indicates the amount of shift in position between the reference and test images* (emphasis added -- i.e. not between part of the reference and test images)." What Hu teaches is detecting (and later correcting for) a bulk shift between two entire, whole images.

Figure 2 of Hu discloses a test region or block 28 mapped out in the reference image and a corresponding test region or block 28 mapped out in the test image. These are "corresponding" blocks in that their size and location within the image they form part of is identical (i.e. in both cases, size is Δx by Δy and offset is x_o, y_o). This clearly establishes that, contrary to the Examiner's interpretation of Hu, the test region or block 28 of the reference image and the test region or block 28 of the test image have zero shift, relative to each other. Both test regions or blocks share precisely the same offset: x_o, y_o and therefore the same position within their respective frames.

Claim 1 requires to *"positioning, ... at least one of the matching sub-field/frame elements"* (i.e. positioning a part of an image, not the whole image). According to claim 1, this positioning is carried out to *"compensate for misalignment between at least one of the sub-field/frame elements ..."* (i.e. misalignment between a part of the two images, not the whole images). Even assuming *arguendo* that the test region or blocks 28 of Hu are alleged to disclose the sub-field/frame elements of claim 1, there is no misalignment to detect or to

compensate for between the test region or blocks of Hu: they are exactly aligned at a common offset x_o, y_o.

In fact, the test region or blocks 28 of Hu are not the matching sub-field/frame elements required by claim 1: they do not match (see mismatching of texture 25 between test regions or blocks 28 in the reference and test images). The shifting described in Hu is fundamentally different from the positioning of claim 1. In Hu, the images are shifted so that the test regions or blocks match. According to claim 1, the sub-field/frame elements are shifted so that the images match.

This is demonstrated by the section of Hu following that quoted by the Examiner. At column 3, lines 42-44: *"[t]he final shift position value output from the spatial alignment detect module is then used to spatially align the test and reference images* (emphasis added)." Hu does not describe spatially aligning parts of two images but the whole image.

Hu therefore does not describe detecting a misalignment between parts of two images as required by claim 1. There is no teaching in Hu of shifting a part of an image, nor of the matched video field frame - both as required by claim 1. Similar comments apply to claims 17 and 20.

In contrast, misalignments within a field or frame are addressed by the invention of the independent claims by positioning or shifting one or more of the matching sub-field/frame elements to compensate for misalignment between the sub-field/frame elements of the test video field/frame and the matching sub-field/frame elements of the matched reference field/frame. According to the invention of the independent claims, the image is modified (not merely shifted) in order to overcome the affects of shifts between parts of images. This is not addressed by the alignment detection method of Hu which teaches detecting shifts only between *whole* images.

The invention of the independent claims relates to the creation of a new matched reference field/frame, which is more than just the shifted version of the reference signal (e.g., as provided by the teachings of Hu). Unlike the cited prior art, where a test region is formed arbitrarily to cover a textured part of the image (column 2, lines 53-59), the invention of the independent claims divides the test array into a plurality of sub-field/frame elements and searches (for example) in the reference signal for a "best match" for each sub-field/frame element. The "best match" sub-field/frame elements are searched for in the reference signal at various offsets to the position of the corresponding sub-field/frame element of the test signal and/or across several adjacent fields/frames. Once selected, each "best match" block is copied into the new, matched reference field/frame and shifted, as necessary, into a position matching the position of the corresponding test sub-field/frame.

In this way, the invention of the independent claims provides compensation for the complex misalignments that may occur within a field or frame, where different parts of a video field or frame might be subject to different shifts, scaling, or delay. These misalignments within a field or frame (i.e. affecting a sub-field/frame element) are not addressed by Hu.

The invention of the independent claims provides significant benefits over the teaching of the cited documents, in particular over Hu, as it enables more effective identification of visually insignificant imperfections in a video signal. By identifying imperfections imperceptible to the human viewer (such as the misaligned image sub-blocks), the invention of the independent claims enables automatic video quality detection to exclude these effects and provide a result better aligned with the experience of a human viewer.

<u>*Dependent claims 51-53*</u>:

Dependent claim 51 further requires "wherein said positioning includes positioning a plurality of the matching sub-field/frame elements to compensate for misalignments between a plurality of the sub-field/frame elements of the test video field/frame and the plurality of the matching sub-field/frame elements." Dependent claims 52 and 53 require similar features. As discussed above, Hu fails to disclose *"<u>positioning</u>, ... at least one of the matching <u>sub-field/frame elements</u>"* (i.e. positioning a <u>part</u> of an image, not the whole image). Hu therefore fails to further disclose positioning a <u>*plurality*</u> of the matching sub-field/frame element<u>s</u> to compensate for misalignments between a <u>*plurality*</u> of the sub-field/frame element<u>s</u> of the test video field/frame and the <u>*plurality*</u> of the matching sub-field/frame element<u>s</u>. As noted above, page 2, lines 25-27 of the original specification identifies the following problem: "more complex, but equally imperceptible, misalignments may also occur within a field or frame, where different <u>regions of a video field or frame</u> might be subject to different shifts, scaling, or delay (emphasis added)." The above-recited limitations of claims 51-53 may enable these different shifts to be compensated since multiple sub-field/frame element<u>s</u> are positioned. Moreover, Hu merely discloses only a single test region of the test and reference images.

Appellant notes the Advisory Action contains serious misquotes of the claim language. For example, the quotation from claim 1 on page 2 (eight lines down) of the Advisory Action includes the following phrase not found in claim 1: *"which match to the sub-field/frame elements of the at least one reference video field/frame."* As another example, with respect to claims 17 and 20, page 2 of the Advisory Action (15 lines down) omits between *"test video field/frame"* and *"and thereby generating"*, the following text from the cited claims: *"with corresponding sub-field/frame elements of at least one reference video field/frame"*. The Examiner's misquotes seriously alter the meaning of the claims.

The Advisory Action also misquotes Hu. In particular, page 3 of the Advisory Action includes the following misquote indicated in the shaded box:

> A high precision sub-pixel spatial alignment algorithm is shown in FIG. 3. An initialization module 30 provides the corresponding reference and test images together with a test block to a correlation measurement module 32. The first step 34 in the initialization module 30 controls the video capture module 16 to capture corresponding reference and test images together with a test block to a correlation measurement module 32. The first step 34 in the initialization module 30 controls the video capture module 16 to capture corresponding reference and test images or frames from the reference and test video signals. The second step

Page 4 of the Advisory Action appears to be alleging that the claimed <u>plurality</u> of sub-field/frame elements reads onto the plurality of pixels within the <u>single</u> test region or block of Figure 2 of Hu. As noted above, Hu uses a single part of a test image and part of a reference image. However, these image parts <u>*(and any pixels therein)*</u> are employed to determine the offset for the <u>entire</u> image, rather than a part.

<u>***Claims 7-10, 26-29 and 41-44 are not obvious under 35 U.S.C. §103(a) over Hu in view of Wolf, and claims 11-16, 30-35 and 45-50 are not obvious under 35 U.S.C. §103(a) over Hu, Wolf and further in view of Kuhn***</u>.

Claims 7-16 depend at least indirectly from claim 1, claims 26-35 depend at least indirectly from claim 20, and claims 41-50 depend at least indirectly from claim 17. All of the comments made above with respect to Hu thus apply equally to claim 7-16, 26-35 and 41-50. Kuhn and/or Wolf fails to resolve the above-described deficiencies of Hu.

Wolf describes a full-reference objective quality assessment method that uses feature extraction followed by quality classification. The feature extraction process requires time-alignment and includes the calculation of "temporal features." Wolf further describes the measurement of various forms of "impairment" based on features extracted from sampled

video, including spatial blurring, temporal blurring, etc. The time-alignment and temporal feature extraction processes of Wolf appear to relate to whole frames. Wolf fails to achieve or even consider the sub-field/frame element matching of claim 1, 17 or 20, or the claimed shifting.

Dependent claim 7 further requires "wherein the matching further comprises calculating one or more matching statistic values and/or matching vectors; and wherein the generating generates the video quality parameter in further dependence on the calculated matching statistic values and/or matching vectors." Dependent claims 26 and 41 require similar features.

The Final Rejection correctly indicates that Wolf refers to statistical analysis. However, this statistical analysis is not part of the video quality assessment arrangement of Figure 2. The statistical analysis described in Wolf forms part of the development process used to design the video quality measurement system illustrated in Figure 2 (see col. 3, lines 4-6), but does not form part of it. The statistical analysis described in Wolf does not generate the one or more matching statistic values and/or matching vectors of claims 7, 26 and 41, but produces a set of source and destination features which determine the internal functioning of the statistics processors 22, 24, 30, and 32 of the video quality measurement system of Figure 2 (see col. 6, lines 3-13). The statistics processors 22, 24, 30, and 32 do not generate statistical values, but compute a set of source features (col. 4, lines 26-35) and destination features (col. 5, lines 13-29). Despite their names, these functional blocks of Wolf do not perform the invention of dependent claim 7, 26 or 41.

The invention of the independent claims acts to minimize the effects of sub-field/frame misalignments that are imperceptible to the human viewer. Wolf fails to teach or suggest this. These "imperceptible" sub-field/frame misalignments are not so severe as to be

noticeable to the human viewer, but can significantly affect the quality value generated by an automatic quality measuring system leading to the generation of inaccurate values. The use of a matching element that is smaller than the video field/frame size enables transient sub-field/frame misalignments to be effectively tracked. This is not identified as being a characteristic of the quality measurement system of Wolf. Indeed, no part of Wolf considers transient sub-field/frame misalignments.

Wolf refers to video frame features from the perspective of bandwidth-reduction. In particular, the source and destination features of Wolf are not sub-fields of a video frame, but bandwidth-reduced representations of the entire frame.

Wolf discloses extraction of features from the video signal being implemented in order to reduce the bandwidth of the signal to allow comparison of signals (source and destination) at geographically remote locations (see col. 3, lines 45-50; col. 5, lines 18-23). According to Wolf, source features are produced by statistics processors 22 and 24 for source video and by statistics processors 30 and 32 for destination video (col. 5, lines 18-21). Col. 5, lines 32-37 discloses that "the system of the [Wolf's] present invention provides human perception-based quality parameters 13 and quality score parameter 14." These features are extracted separately from source and destination videos and exchanged between source and destination "instruments" via a communications channel distinct from the video channel. These features are generated by extracting information from the true video signals and processing that information in the hope of capturing perception-affecting characteristics for comparison.

CONCLUSION

In conclusion it is believed that the application is in clear condition for allowance; therefore, early reversal of the Final Rejection and passage of the subject application to issue are earnestly solicited.

Respectfully submitted,

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(VIII) CLAIMS APPENDIX

1. A video quality assessment method, comprising:

matching, by execution of a computer system, sub-field/frame elements of a test video field/frame with corresponding sub-field/frame elements of at least one reference video field/frame, and thereby generating for the test video field/frame a matched reference field/frame comprising the sub-field/frame elements of the at least one reference video field/frame which match to the sub-field/frame elements of the test video field/frame;

positioning, by execution of the computer system, in the matched reference video fields/frame at least one of the matching sub-field/frame elements to compensate for misalignment between at least one of the sub-field/frame elements of the test video field/frame and the at least one matching sub-field/frame elements; and

generating, by execution of the computer system, a video quality value in dependence on the matched sub-field/frame elements of the test and matched reference video fields/frames so as to reduce the adverse effects of sub-field/frame misalignments between the reference and test field/frames.

2. A method according to claim 1, wherein the matching further comprises, for a sub-field/frame element of the test video field/frame, searching for a matching sub-field/frame element within M1 preceding and/or M2 succeeding reference video fields/frames to a temporally corresponding reference video field/frame to the test video field/frame.

3. A method according to claim 2, wherein M1 and M2 are predefined.

4. A method according to claim 2, wherein the searching further comprises searching within a spatially bounded region of the reference video fields/frames about the corresponding position within the reference fields/frames as the test sub-field/frame element takes within the test video field/frame.

5. A method according to claim 4, wherein the spatial bound of the search region is predefined.

6. A method according to claim 1, wherein the matching further comprises, for a sub-field/frame element of the test video field/frame:

defining a matching template comprising a portion of the test video field/frame including the sub-field/frame element; and

using the defined matching template to search for matching sub-field/frame elements in the at least one reference video field/frame.

7. A method according to claim 1, wherein the matching further comprises calculating one or more matching statistic values and/or matching vectors; and wherein the generating generates the video quality parameter in further dependence on the calculated matching statistic values and/or matching vectors.

8. A method according to claim 7, wherein the calculating comprises:

constructing one or more histograms relating to the searched area(s) of the reference video field(s)/frame(s); and

calculating a matching statistic value for each histogram relating to the proportion of matched elements which contribute to the peak of the histogram.

9. A method according to claim 1, wherein the generating further comprises:

calculating a plurality of video characteristic values respectively relating to characteristics of the test and/or reference video fields/frames in dependence on the matched sub-field/frame elements of the test and reference video fields/frames; and

integrating at least the calculated video characteristic values together to give the video quality value.

10. A method according to claim 9, wherein the matching further comprises calculating one or more matching statistic values and/or matching vectors; and wherein the generating generates the video quality parameter in further dependence on the calculated matching statistic values and/or matching vectors; and wherein the integrating further includes integrating the matching statistic value (s) with the calculated video characteristic values to give the video quality value.

11. A method according to claim 9, wherein the video characteristic values are respectively any two or more of the following values: one or more spatial frequency values; one or more texture values; at least one edge value; at least one luminance signal to noise ratio value; and/or one or more chrominance signal to noise ratio values.

12. A method according to claim 11, wherein the calculation of the edge value comprises, for a test field/frame:

counting a number of edges in each sub-field/frame element of the test field/frame;

counting a number of edges in each sub-field/frame element of the at least one reference field/frame matched to the sub-field/frame elements of the test field/frame; and

determining an edge value for the test field/frame in dependence on the respective counts.

13. A method according to claim 12, wherein the determining further comprises:

calculating difference values between each pair of respective counts;

putting each calculated difference value to the power Q;

summing the resulting values to give a sum value; and

putting the sum value to the power 1/Q to give the edge value.

14. A method according to claim 9, wherein the integrating further comprises weighting each value by a predetermined weighting factor; and summing the weighted values to give the video quality value.

15. A method according to claim 14, wherein the summing is further arranged to sum the weighted values with a predetermined offset value.

16. A method according to claim 14, wherein the weighting factors and the offset value are dependent on the type of the test and reference video fields/frames.

17. A non-transitory computer readable storage medium storing at least one computer program which upon execution by a computer system performs a video quality assessment method, the method comprising:

matching sub-field/frame elements of a test video field/frame with corresponding sub-field/frame elements of at least one reference video field/frame, and thereby generating for the test video field/frame a matched reference field/frame comprising the sub-field/frame elements of the at least one reference video field/frame which match to the sub-field/frame elements of the test video field/frame;

shifting, by execution of the computer system, relative to the matched reference field/frame at least one of the matching sub-field/frame elements to compensate for misalignment between at least one of the sub-field/frame elements of the test video field/frame and the at least one matching sub-field/frame elements; and

generating a video quality value in dependence on the matched sub-field/frame elements of the test and matched reference video fields/frames so as to reduce the adverse effects of sub-field/frame misalignments between the reference and test field/frames.

18. (canceled)

19. (canceled)

20. A system for video quality assessment, comprising:

matching means for matching sub-field/frame elements of a test video field/frame with corresponding sub-field/frame elements of at least one reference video field/frame, and thereby generating for the test video field/frame a matched reference field/frame comprising the sub-field/frame elements of the at least one reference video field/frame which match to the sub-field/frame elements of the test video field/frame;

shifting means for shifting relative to the matched reference field/frame at least one of the matching sub-field/frame elements to compensate for misalignment between at least one of the sub-field/frame elements of the test video field/frame and the at least one matching sub-field/frame elements of the at least one reference video field/frame; and

video processing means arranged in use to generate a video quality value in dependence on the matched sub-field/frame elements of the test and matched reference video fields/frames so as to reduce the adverse effects of sub-field/frame misalignments between the reference and test field/frames.

21. A system according to claim 20, wherein the matching means further comprises, temporal searching means arranged in use to search for a matching sub-field/frame element within M1 preceding and/or M2 succeeding reference video fields/frames to a temporally corresponding reference video field/frame to the test video field/frame.

22. A system according to claim 21, wherein M1 and M2 are predefined.

23. A system according to claim 21, and further comprising spatial searching means arranged in use to search within a spatially bounded region of the reference video fields/frames about the corresponding position within the reference fields/frames as the test sub-field/frame element takes within the test video field/frame.

24. A system according to claim 23, wherein the spatial bound of the search region is predefined.

25. A system according to claim 20, wherein the matching means further comprises:

means for defining a matching template comprising a portion of the test video field/frame including the sub-field/frame element; and

means for using the defined matching template to search for matching sub-field/frame elements in the at least one reference video field/frame.

26. A system according to claim 20, wherein the matching means further comprises calculating means arranged in use to calculate one or more matching statistic values and/or matching vectors; and wherein the video processing means is further arranged in use to generate the video quality parameter in further dependence on the calculated matching statistic values and/or matching vectors.

27. A system according to claim 26, wherein the calculating means further comprises:

histogram constructing means arranged in use to construct one or more histograms relating to the searched area (s) of the reference video field(s)/frame(s); and

matching statistic calculating means for calculating a matching statistic value for each histogram relating to the proportion of matched elements which contribute to the peak of the histogram.

28. A system according to claim 20, wherein the video processing means further comprises:

a plurality of analysis means respectively arranged in use to calculate a plurality of video characteristic values respectively relating to characteristics of the test and/or reference video

fields/frames in dependence on the matched sub-field/frame elements of the test and reference video fields/frames; and

an integration means for integrating at least the calculated video characteristic values together to give the video quality value.

29. A system according to claim 28, wherein the matching means further comprises calculating means arranged in use to calculate one or more matching statistic values and/or matching vectors; and wherein the video processing means is further arranged in use to generate the video quality parameter in further dependence on the calculated matching statistic values and/or matching vectors; and wherein the integration means is further arranged to integrate the matching statistic value(s) with the calculated video characteristic values to give the video quality value.

30. A system according to claim 28, wherein the video characteristic values are respectively any two or more of the following values: one or more spatial frequency values; one or more texture values; at least one edge value; at least one luminance signal to noise ratio value; and/or one or more chrominance signal to noise ratio values.

31. A system according to claim 30, and further comprising edge calculation means comprising:

means for counting a number of edges in each sub-field/frame element of the test field/frame;

means for counting a number of edges in each sub-field/frame element of the at least one reference field/frame matched to the sub-field/frame elements of the test field/frame; and

means for determining an edge value for the test field/frame in dependence on the respective counts.

32. A system according to claim 31, wherein the means for determining further comprises an arithmetic calculator means arranged in use to:

calculate difference values between each pair of respective counts;

put each calculated difference value to the power Q;

sum the resulting values to give a sum value; and

put the sum value to the power 1/Q to give the edge value.

33. A system according to claim 28, wherein the integrating means further comprises weighting means for weighting each value by a predetermined weighting factor; and summing means for summing the weighted values to give the video quality value.

34. A system according to claim 33, wherein the summing means is further arranged to sum the weighted values with a predetermined offset value.

35. A system according to claim 33, wherein the weighting factors and the offset value are dependent on the type of the test and reference video fields/frames.

36. A non-transitory computer readable storage medium according to claim 17, wherein the matching further comprises, for a sub-field/frame element of the test video field/frame, searching for a matching sub-field/frame element within M1 preceding and/or M2 succeeding

reference video fields/frames to a temporally corresponding reference video field/frame to the test video field/frame.

37. (currently amended) A non-transitory computer readable storage medium according to claim 36, wherein M1 and M2 are predefined.

38. A non-transitory computer readable storage medium according to claim 36, wherein the searching further comprises searching within a spatially bounded region of the reference video fields/frames about the corresponding position within the reference fields/frames as the test sub-field/frame element takes within the test video field/frame.

39. A non-transitory computer readable storage medium according to claim 38, wherein the spatial bound of the search region is predefined.

40. A non-transitory computer readable storage medium according to claim 17, wherein the matching further comprises, for a sub-field/frame element of the test video field/frame:

defining a matching template comprising a portion of the test video field/frame including the sub-field/frame element; and

using the defined matching template to search for matching sub-field/frame elements in the at least one reference video field/frame.

41. A non-transitory computer readable storage medium according to claim 17, wherein the matching further comprises calculating one or more matching statistic values and/or

matching vectors; and wherein the generating generates the video quality parameter in further dependence on the calculated matching statistic values and/or matching vectors.

42. A non-transitory computer readable storage medium according to claim 41, wherein the calculating comprises:

constructing one or more histograms relating to the searched area (s) of the reference video field(s)/frame (s); and

calculating a matching statistic value for each histogram relating to the proportion of matched elements which contribute to the peak of the histogram.

43. A non-transitory computer readable storage medium according to claim 17, wherein the generating further comprises:

calculating a plurality of video characteristic values respectively relating to characteristics of the test and/or reference video fields/frames in dependence on the matched sub-field/frame elements of the test and reference video fields/frames; and

integrating at least the calculated video characteristic values together to give the video quality value.

44. A non-transitory computer readable storage medium according to claim 43, wherein the matching further comprises calculating one or more matching statistic values and/or matching vectors; and wherein the generating generates the video quality parameter in further dependence on the calculated matching statistic values and/or matching vectors; and wherein the integrating further includes integrating the matching statistic value (s) with the calculated video characteristic values to give the video quality value.

45. A non-transitory computer readable storage medium according to claim 43, wherein the video characteristic values are respectively any two or more of the following values: one or more spatial frequency values; one or more texture values; at least one edge value ; at least one luminance signal to noise ratio value; and/or one or more chrominance signal to noise ratio values.

46. A non-transitory computer readable storage medium according to claim 45, wherein the calculation of the edge value comprises, for a test field/frame:

counting a number of edges in each sub-field/frame element of the test field/frame;

counting a number of edges in each sub-field/frame element of the at least one reference field/frame matched to the sub-field/frame elements of the test field/frame; and

determining an edge value for the test field/frame in dependence on the respective counts.

47. A non-transitory computer readable storage medium according to claim 46, wherein the determining further comprises:

calculating difference values between each pair of respective counts;

putting each calculated difference value to the power Q;

summing the resulting values to give a sum value ; and putting the sum value to the power 1/Q to give the edge value.

48. A non-transitory computer readable storage medium according to claim 43, wherein the integrating further comprises weighting each value by a predetermined weighting factor; and summing the weighted values to give the video quality value.

49. A non-transitory computer readable storage medium according to claim 48, wherein the summing is further arranged to sum the weighted values with a predetermined offset value.

50. A non-transitory computer readable storage medium according to claim 48, wherein the weighting factors and the offset value are dependent on the type of the test and reference video fields/frames.

51. A method according to claim 1, wherein said positioning includes positioning a plurality of the matching sub-field/frame elements to compensate for misalignments between a plurality of the sub-field/frame elements of the test video field/frame and the plurality of the matching sub-field/frame elements.

52. A non-transitory computer readable storage medium according to claim 17, wherein said positioning includes positioning a plurality of the matching sub-field/frame elements to compensate for misalignments between a plurality of the sub-field/frame elements of the test video field/frame and the plurality of the matching sub-field/frame elements.

53. A system according to claim 20, wherein the shifting means shifts, relative to the matched reference field/frame, a plurality of the matching sub-field/frame elements to compensate for misalignments between a plurality of the sub-field/frame elements of the test video field/frame and the plurality of matching sub-field/frame elements of the at least one reference video field/frame.

(IX) EVIDENCE APPENDIX

None.

(X) RELATED PROCEEDINGS APPENDIX

None.